CLAIMS

What is claimed is:

1. A vibration and isolation apparatus comprising:

a fluid having a true fluid weight, a density and a viscosity;

a first fluid containment chamber containing a first portion of the fluid;

a second containment chamber containing a second portion of the fluid;

a damping path between the first fluid containment chamber and the second fluid containment chamber; and

wherein the ratio of the cross sectional area of the first fluid containment chamber and the second fluid containment chamber to the cross sectional area of the damping path is chosen to produce an effective mass of the fluid to enhance vibration damping and isolation.

2. The apparatus of claim 1 wherein the cross sectional area of the damping path can be changed to permit active tuning of the effective mass of the fluid.

3. The apparatus of claim 1 wherein the cross sectional area of the first fluid containment chamber or the second fluid containment chamber can be varied to permit active tuning of the effective mass of the fluid.

4. The apparatus of claim 1 wherein the apparatus supports a payload having a fixed mass.

5. The apparatus of claim 4 wherein the true mass of the fluid is less than the mass of the payload and the effective mass of the fluid is greater than or equal to the mass of the payload.

6. The apparatus of claim 1 wherein the effective fluid mass of the fluid is chosen to give the apparatus a roll-off of –60dB per decade for at least one decade after a significant resonance.

7. The apparatus of claim 1 wherein the density of the fluid can be changed to change the effective fluid mass.

8. A fluid filled isolator for vibration damping and isolation, the mechanical equivalent of isolator comprising four tunable parameters and wherein the four tunable parameters comprising a first spring in parallel with a second spring, an effective fluid mass and a first damper in series.

9. The isolator of claim 8 wherein the effective fluid mass is equal to the true fluid mass multiplied by an amplification factor.

10. The isolator of claim 9 wherein the true fluid mass is less than a mass of a payload coupled to the isolator and the effective mass is equal to or greater than the mass of the payload.

11. The isolator of claim 10 wherein the first spring force is formed by a stiffness formed by the design of a first fluid chamber and a second fluid chamber.

12. The isolator of claim 11 wherein the damper is substantially provided by the shear force of the fluid through a damping annulus located between the first fluid chamber and the second fluid chamber.

13. The isolator of claim 12 wherein the second spring force is formed from a volumetric stiffness of the first fluid containment chamber and the second fluid containment chamber and axial stiffness coupled to the first fluid containment chamber and the second fluid containment chamber.

14. The isolator of claim 13 wherein the effective fluid mass is proportional to the ratio of the cross sectional area of the first fluid containment chamber and the second fluid containment chamber divided by the cross sectional area of the damping annulus, the quantity squared.

15. The isolator of claim 8 wherein the effective fluid mass to payload mass is chosen to provide a roll-off –60dB per decade for at least one decade after a significant resonance.

16. A fluid filled damping and isolation apparatus, comprising:

a shaft having an axis therethrough, the shaft having a first and second end;

a piston having an axial bore coaxially positioned with the shaft to provide a damper by forming a damping path therebetween, the piston having a flange extending radially therefrom for coupling the apparatus to a load;

a first extension coupled to and extending radially from the first end of the shaft;

a second extension coupled to and extending radially from the second end of the shaft;

secondary isolation means coaxially extending from the first and second extensions for providing a first volumetric stiffness in series with the damper;

primary isolation means connecting the flange to the first extension and the second extension and coaxial with the shaft for providing a second volumetric stiffness in parallel with the damper and the secondary isolation means, the secondary isolation means connected to the primary isolation means via fluid paths through the first and second extensions; and

wherein the ratio of a cross sectional area of the primary isolations means to a cross sectional area of the damping path are chosen to provide a fluid mass effect.

17. The apparatus of claim 16 wherein the cross sectional area of the primary isolation means can be varied to permit active tuning of the fluid mass effect.

18. The apparatus of claim 16 wherein the cross sectional area of the damping path can be changed to permit active tuning of the fluid mass effect.

19. The apparatus of claim 16 wherein the fluid mass effect is chosen to give the apparatus a roll-off of –60dB per decade for at least one decade after a significant resonance.

20. The apparatus of claim 16 wherein the fluid mass effect can be change by varying the mass of a fluid internal to the apparatus.

21. An isolation and vibration damping system comprising:

a platform for securing a payload; and

a plurality of isolation struts attached at one end to the platform and at a second end to a base, the mechanical equivalent of each of the plurality of isolation struts comprising four tunable parameters, the four tunable parameters comprising a first spring in parallel with a second spring, an effective fluid mass and a damper in series.

22. The system of claim 21 wherein the first spring force is formed by a stiffness formed by the design of a first fluid chamber and a second fluid chamber.

23. The system of claim 22 wherein the damper is substantially provided by a shear force of a fluid through a damping annulus located between the first fluid chamber and the second fluid chamber.

24. The system of claim 23 wherein the second spring force is formed from a volumetric stiffness of the first fluid containment chamber and the second fluid containment chamber and axial stiffness coupled to the first fluid containment chamber and the second fluid containment chamber.

25. The system of claim 24 wherein the effective fluid mass is proportional to the ratio of the cross sectional area of the first fluid containment chamber and the second fluid containment chamber divided by the cross sectional area of the damping annulus, the quantity squared.